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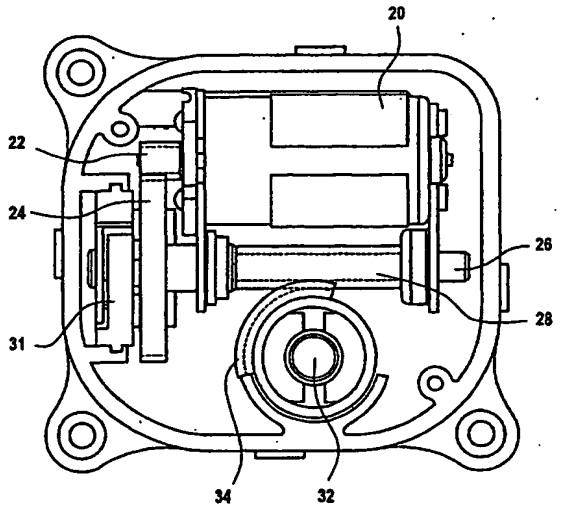
(54) A drive mechanism with an electromotor driving a mechanical transmission with a forceback facility

(57) A drive mechanism with an electromotor driving a mechanical transmission for converting a rotation into a rotary or linear movement for a mechanical actuator, with a forceback facility through a return spring that is arranged for effecting a rotary return force towards a fallback position effected on an axis that forms part of the transmission.

An electromechanical drive mechanism comprises a driving electromotor (20) provided with a rotatable driving first axis, and mechanical transmission means (22, 24, 28, 34) driven by said rotatable driving first axis, for through converting a first rotary movement of the rotatable driving first axis into a second rotary or linear movement of an actuator member (32) driving a mechanical actuator along a range of actuator positions. The drive mechanism is furthermore provided with an forceback facility (30, 31, 32, 38) for effecting a return force on the drive mechanism towards a fallback position. The drive mechanism is furthermore mounted in a housing facility (34).

In particular, the drive mechanism has the forceback facility (30, 31, 36, 38) operated in a mechanical manner and comprising a return spring (31, 36, 38) that is arranged for effecting a rotary return force on a rotatable axis (26) that forms part of the mechanical transmission means.

FIG 1



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Description

[0001] A drive mechanism with an electromotor driving a mechanical transmission for converting a rotation into a rotary or linear movement for a mechanical actuator, with a forceback facility through a return spring that is arranged for effecting a rotary return force towards a fallback position effected on an axis that forms part of the transmission.

[0002] The invention relates to an electromechanical drive mechanism comprising a driving electromotor provided with a rotatable driving first axis, and mechanical transmission means driven by said rotatable driving first axis, for through converting a first rotary movement of said rotatable driving first axis into a second rotary or linear movement of an actuator member driving a mechanical actuator along a range of actuator positions, said drive mechanism furthermore being provided with a forceback facility for thereby effecting a return force of said drive mechanism towards a fallback position and said drive mechanism being furthermore mounted in a housing facility. Such drive mechanisms are ubiquitous in various fields of application and within a wide range of driving force and power ratings; among the various advantageous properties of the principle are its accurate, time-uniform and fine-grained responses.

[0003] Naturally, and more in particular in applications where a light overall weight is a primary requisite, such as is the case, but is not limited to application in motor vehicles, designers will tend to choose low power ratings for the motor. A potential problem then exists when the actuator will for an extended period of time be driven at a certain fixed position, but must be returned quasi-instantaneously to a fallback position. The inventors have recognized the potential danger for overload and damage of the electric motor, and also the zero-power quality of mechanical means for in various situations such as, but not being limited to, emergency situations effecting stepping, and thereby effectively faster, changes of position.

[0004] In consequence, amongst other things, it is an object of the present invention to supplement the advantageous aspects of electrical control with an advantageous complement thereto in the form of mechanical supplementary facilities, so that certain rotary motions can be effected quickly and without danger for electrical overload.

[0005] Now therefore, according to one of its aspects the invention is characterized in that said forceback facility is operated in a mechanical manner and comprises a return spring that is arranged for effecting a rotary return force on a rotatable axis that forms part of said mechanical transmission means. Depending on the dimensioning of the electromechanical drive mechanism, the return spring may, or may not be operative to on its own effectively bring about a return motion to the fallback position in the direction of the return force. The pertinent design considerations could include the return being part of an emergency situation or not, the requirements for low-power operation in the steady and non-moving state, and the self-braking aspects, or otherwise, of the ultimate members of the mechanism.

[0006] By itself, a drive mechanism that has return springs operating on a throttle drum in an automotive environment has been disclosed in Patent Application EP 0 831 215 A1. Here, the spring action is effected immediately on the actuator itself, i.e., the throttle drum proper. In contradistinction, the serial arrangement of the various parts of the drive mechanism according to the present invention allows for a wide range of operating conditions, a great flexibility in design characteristics, and a fine-tunability of the operation of the mechanism.

[0007] Advantageously, the rotary return force is effected on a rotatable second axis that is rotatably engaged with the rotatable first axis. This allows the designer to adroitly adapt the force by the return spring to the amounts of movement and force that must be controlled with respect to the eventual movement of the actuator.

[0008] The rotatable second axis may either carry a worm arrangement or a spindle arrangement. The self-braking character of such arrangements may operate to help effecting a motion control of the overall drive mechanism. The topology of the return spring may be that of a spiral. In contradistinction, the return springs of the reference have the topology of a cylindrical screw. The present realization is believed to have advantageous properties regarding the exerted forces and the space necessary for the mechanism. Further advantageous aspects of the invention are recited in dependent Claims.

[0009] These and further aspects and advantages of the invention will be discussed more in detail hereinafter with reference to the disclosure of preferred embodiments, and in particular with reference to the appended Figures that show:

- Figure 1, an overall arrangement of the disclosed embodiment of the present invention;
- Figure 2, a perspective outside view of the principal components of Figure 1;
- Figure 3, a perspective view of the return spring in its supporting housing.

[0010] Figure 1 illustrates an overall arrangement of the disclosed embodiment of the present invention. A housing 34 such as made from cast aluminum is boltable by appropriate holes to an overall support structure not shown. The primary driving force for the electromechanical drive mechanism is provided by electric motor 20 that may without limitation have a power rating within a range of 5 watts to 1 kilowatt. For brevity, electric connections as well as the specific type of motor have not been shown. The motor axis carries a small output gearwheel 22, of which the number of teeth is in the order of

10. This output gearwheel engages with a rather larger gearwheel 24 which is mounted on axis 26, and which has a number of teeth in the order of 60. Moreover this latter axis carries a worm 26 that engages with worm gearwheel 34 which is mounted on axis 32 that runs perpendicular to the drawing plane. This latter axis is connected to an actuator not shown for brevity, which may be used for controlling any of several parameters of a vehicle motor, such as throttle. In particular, but not by way of limitation, such actuator could be used for effecting cruise control.

[0011] Furthermore, the arrangement comprises a return spring housed within part 31, and which return spring is mounted together with gearwheel 24. In particular circumstances, such as emergencies, it may be necessary to return the actuator quasi-instantaneously to a fallback position, to which effect this spring can deliver an appropriate force. The combination of this force and the electrically applied motor force could effectively surpass the performance characteristics of the motor alone. Without such extra force, the motor could effectively be damaged while delivering the required power, even if only for a brief time. Through mounting the return spring on secondary axis 26, the number of rotations to be effectively generated on its "own" axis is less than would have been the case for the motor axis itself. This allows to meticulously adjust the spring force to the motor's.

[0012] As a variation, the worm 28 may be replaced by a spindle, that would be arranged to impart on an engaging counterpart member a linear movement in the direction of axis 26. By themselves spindle-based transmissions are well known in the art, and for application with certain types of actuators, such linear movement would be considered superior. For brevity, the spindle embodiment has not been shown explicitly; notably, the set-up of electric motor, first and second gearwheels and return spring could be similar to the setup effectively shown.

[0013] As a further variation, the arrangement of the worm and worm-gearwheel combination can be self-braking. This means that under a condition of heavy load, wherein the electric motor cannot move its output gearwheel 22, such may be detected by means not shown in the Figure, for then maintaining the motor without powering in its actual position. This represents a further safety measure against overload damage of the motor. Of course, a similar approach would do in the case of a spindle drive organization. Furthermore, the return spring could be operative for on itself effecting or return movement to the fallback position, or contrariwise, needing always assistance from the electric motor therefor.

[0014] Figure 2 illustrates a perspective outside view of the principal components of Figure 1. Certain numerals of Figure 1 have been copied in this Figure. Electric motor 20, two gearwheels 22, 24, secondary axis 26, worm and worm gearwheel 28, 34, and output axis 32 are visible. The Figure as shown has been produced by a Computer Aided Design system, as is broadly used in the art. The worm and worm gearwheel combination has been designed for self-operated output braking. In various circumstances, this would render continuous powering of motor 20 superfluous, so that only differential powering were necessary. The return spring arrangement is housed in part 31.

[0015] Figure 3 illustrates a perspective view of the return spring in its supporting housing 31. As shown, the substance of the spring is a rather narrow thin strip that has been wound according to the overall topology of a spiral. Now, whereas the main length of the spring has apparently been wound in multiple and closely spaced windings 30, the two ends 36 and 38 diverge somewhat therefrom and carry half loops or curves for fixing or mounting to axis 26 and to the housing 31, respectively. This allows the spring under appropriate conditions to exert a sufficient amount of force to effect rotary motion of axis 26 and in consequence, also actuator axis 32. For brevity, the fixating of the spring 30 to the housing 31 and axis 26, respectively, have not been shown explicitly.

[0016] The concept has been designed for allowing actuator cycles with steady postioning for extended periods of time, that may be terminated by intermittent or fallback control of the overall electromechanical arrangement. By itself, such could represent an overload condition. From another viewpoint, in comparison with such steady positioning, during brief time periods such as during an emergency, the transmission could be used could at higher power levels that allowed for the motor, thereby delivering greater actuator power. The construction with a worm arrangement will furthermore allow for a rotation of the output axis, which effectively yields a very low build.

[0017] In the above, the present invention has been described with reference to a disclosure and drawings that illustrate a preferred embodiment. Persons skilled in the art would however from inspecting thereof recognize various changes and amendments to such preferred embodiment. For example, instead of using a special type of spiral spring as described above, it is alternatively possible to applicate other types of springs (for example a torsion spring) depending on the transmission layout. Therefore, the disclosure herein should be considered by way of example, rather than by way of restriction, and the due scope of the present invention should be determined from the Claims appended hereto.

Claims

1. An electromechanical drive mechanism comprising a driving electromotor (20) provided with a rotatable driving first axis, and mechanical transmission means (22, 24, 28, 34) driven by said rotatable driv-

ing first axis, for through converting a first rotary movement of said rotatable driving first axis into a second rotary or linear movement of an actuator member (32) driving a mechanical actuator along a range of actuator positions, said drive mechanism furthermore being provided with a forceback facility (30, 31, 36, 38) for thereby effecting a return force of said drive mechanism towards a fallback position and said drive mechanism being furthermore mounted in a housing facility, said drive mechanism being **characterized in that** said forceback facility (30, 31, 36, 38) is operated in a mechanical manner and comprises a return spring (30) that is arranged for effecting a rotary return force on a rotatable axis (26) that forms part of said mechanical transmission means.

2. A drive mechanism as claimed in Claim 1, being **characterized in that** said rotary return force is effected on a rotatable second axis (26) that is rotatably engaged with said rotatable first axis.

3. A drive mechanism as claimed in Claim 2, being **characterized in that** said rotatable second axis (26) carries a worm (28) that is engaged with a worm gearwheel (34) that is arranged for executing said second rotary movement.

4. A drive mechanism as claimed in Claim 3, being **characterized in that** said worm gearwheel has a gearwheel axis perpendicular to said rotatable driving first axis.

5. A drive mechanism as claimed in Claim 2, being **characterized in that** said rotatable second axis (26) carries a spindle that is engaged with means that are arranged for executing said linear movement.

6. A drive mechanism as claimed in Claim 1, being **characterized in that** said return spring (30, 36, 38) has the topology of a spiral.

7. A drive mechanism as claimed in Claim 6, being **characterized in that** said return spring (30, 36, 38) is constituted by a band that is wound around and fixated to said rotatable second axis.

8. A drive mechanism as claimed in Claim 2, being **characterized in that** said rotatable first axis and said rotatable second axis carry mutually engaging gearwheels.

9. A drive mechanism as claimed in Claim 8, being **characterized in that** said rotatable first axis rotates substantially faster than said rotatable second axis.

10. A drive mechanism as claimed in Claim 3, being **characterized in that** said worm and worm gearwheel arrangement is self-braking.

11. A drive mechanism as claimed in Claim 5, being **characterized in that** said spindle drive arrangement is self-braking.

12. A drive mechanism as claimed in Claim 1, being **characterized in that** said return force is operative for effecting a return motion to said fallback position under an emergency condition.

FIG 1

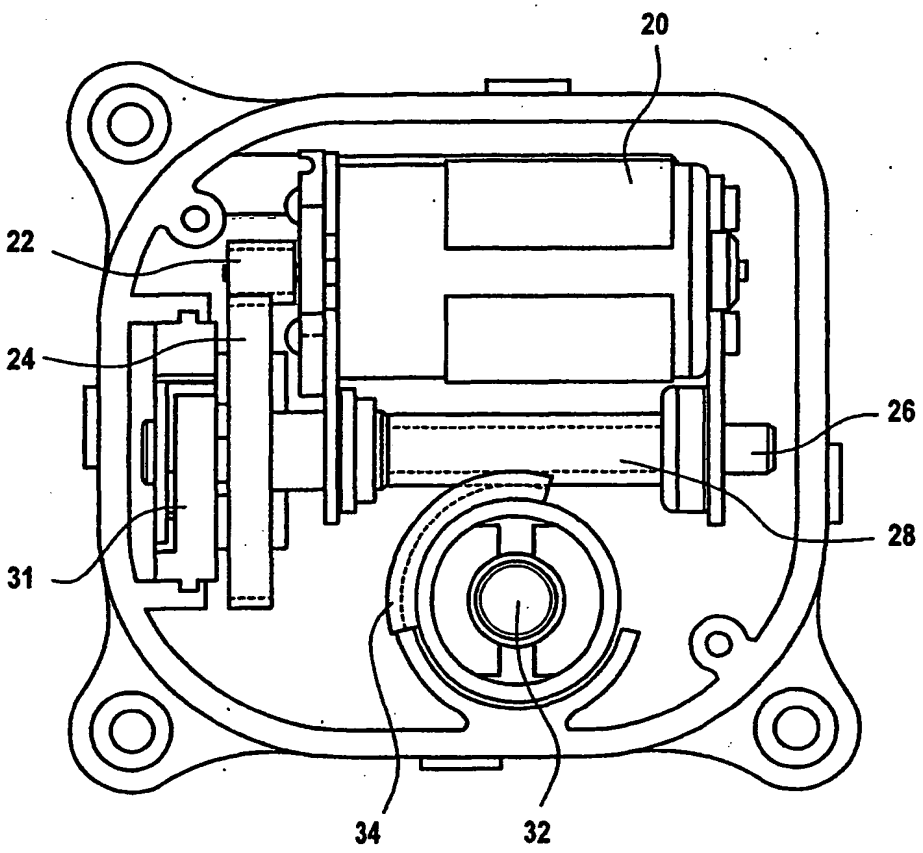


FIG 2

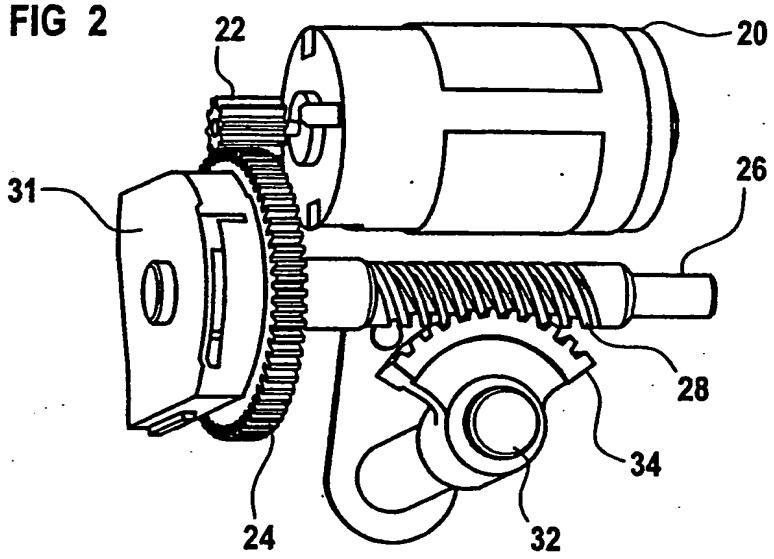
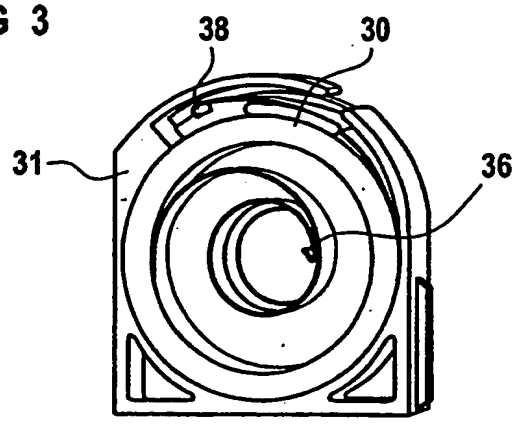


FIG 3



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EUROPEAN SEARCH REPORT

Application Number
EP 02 01 3263

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	EP 1 101 919 A (EATON CORP) 23 May 2001 (2001-05-23) * column 1, line 5 - line 10 * * column 4, line 1 - line 6; figure 2 *	1-6,8,12	F02D11/10
A	PATENT ABSTRACTS OF JAPAN vol. 017, no. 558 (M-1493), 7 October 1993 (1993-10-07) & JP 05 156964 A (HONDA MOTOR CO LTD), 22 June 1993 (1993-06-22) * abstract *	1	
D,A	EP 0 831 215 A (HADSYS INC) 25 March 1998 (1998-03-25) * figure 1 *	1	
A	US 5 775 292 A (SEEGER ARMIN) 7 July 1998 (1998-07-07) * figures 1,2 *	1	
A	EP 1 170 487 A (VISTEON GLOBAL TECH INC) 9 January 2002 (2002-01-09) * figure 2 *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.7) F02D
A	EP 1 099 842 A (VISTEON GLOBAL TECH INC) 16 May 2001 (2001-05-16) * figure 3 *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 016, no. 197 (P-1350), 12 May 1992 (1992-05-12) & JP 04 030143 A (FUJI PHOTO FILM CO LTD), 3 February 1992 (1992-02-03) * abstract *	1	

-/--

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 November 2002	Alconchel y Ungria,J

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Application Number
EP 02 01 3263

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 06, 28 June 1996 (1996-06-28) & JP 08 028649 A (MASATOSHI ASANO;OTHERS: 01), 2 February 1996 (1996-02-02) * abstract *	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 November 2002	Alconchel y Ungria,J

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EPO FORM 1503 03.82 (P04C01)

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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20-11-2002

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1101919 A	23-05-2001	US 6276664 B1 EP 1101919 A2 JP 2001207873 A	21-08-2001 23-05-2001 03-08-2001
JP 05156964 A	22-06-1993	NONE	
EP 0831215 A	25-03-1998	EP 0831215 A1 DE 69611673 D1 DE 69611673 T2	25-03-1998 01-03-2001 17-05-2001
US 5775292 A	07-07-1998	DE 19524941 A1	09-01-1997
EP 1170487 A	09-01-2002	EP 1170487 A2	09-01-2002
EP 1099842 A	16-05-2001	US 6253732 B1 EP 1099842 A2	03-07-2001 16-05-2001
JP 04030143 A	03-02-1992	NONE	
JP 08028649 A	02-02-1996	NONE	

EPO FORM P0459

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